Revolutionising composite recycling: DeremCo's journey towards a circular economy

DISSEMINATION
AFIL/DEREMCO

Navigating the complexities of recycling and reusing composite materials poses a significant challenge to Europe's sustainability aspirations. Composite global production is around 10 million tons per year. Fibre-reinforced plastics (FRPs) are widely used in high-volume products across various industries, including electronics, sports, medical, automotive, construction, wind energy, aeronautics and marine, thanks to their lightweight properties and superior corrosion resistance compared to metals.

Nevertheless, the recovery of plastics and fibres after the use phase of such products is a pressing issue: at their end of life (EoL), composite products generate waste that is difficult to manage due to the intrinsic resistance of the materials. The possibility of identifying alternative circular solutions to landfilling or incineration would reduce environmental impacts, decrease raw material needs, and generate market value through the production of new goods from waste.

In response to this, DeremCo (De-and Remanufacturing for Circular Economy Investments in the Composite Industry) is one of the first I3 (Interregional Innovation Investments) instrument projects. DeremCo seeks to revolutionise the treatment of post-use composite materials, transforming them into valuable resources for manufacturing. With a consortium of 30 partners from seven EU regions, including leaders in composite utilisation and technical expertise, the project is poised to drive interregional collaboration and propel the composite industry forward, developing innovative solutions inspired by sustainable manufacturing and digitalisation. Through rigorous validation processes, the project seeks to validate demanufacturing techniques, ensuring their viability for widespread adoption. And with a portfolio of business investments centred on reprocessing and reusing composite materials, DeremCo aims to catalyse sustainable growth and investment across European value chains.

Industrial demonstration and uptake: two circular pilot strategies

Focused on industrial demonstration and uptake, DeremCo undertakes 14 investment projects, clustered in two circular economy strategies aiming to unlock the systematic reuse of post-use composites across multiple sectors.

Pilot strategy one

Composite granule demanufacturing, hybrid reprocessing and re-use focuses on retrieving the highest value from glass fibre reinforced plastic (GFRP), carbon fibre reinforced plastic (CFRP) and natural fibre composites (NFC) waste, recycled through mechanical processes. The materials processed include thermoset and thermoplastic GFRP scraps of production, thermoset CFRP and NFC scraps from EoL wind turbine blades and the automotive sector.

Pilot strategy two

Long fibre and matrix demanufacturing involves the processes, materials and use cases that are achieved using recycled fibres obtained through thermo-chemical processes, in which the composite materials are recycled through the application of a thermal cycle above the degradation temperature of the matrices and with a non-oxidising atmosphere, allowing the non-degradation of the fibres at that temperature. In some cases, the non-oxidising atmosphere contains specific gases that help recover chemicals that could, at the same time, be reused after a condensation step.

Each pilot strategy has produced and employed different intermediate materials, or semi-finished products, i.e., components made from recycled materials and ready to be used in industry for reprocessing into a final recycled product. It is of great importance that intermediate materials fulfil the manufacturing and reprocessing requirements, meeting quality and technical specifications necessary for their application in different sectors and environments. In this way, the introduction of recycled materials into the industry and subsequent market is highly facilitated.

In strategy one, the development of intermediate materials has followed two distinct routes: thermoset-based composites and thermoplastic-based composites. The work done for thermoset composites includes the preparation of bulk moulding compound (BMC) and the preparation of non-woven mat, while recipes for thermoplastic composites were fine-tuned by adding ground waste from EoL wind blades tailored to individual demo cases.

In strategy two, a specific pretreatment was developed to increase the matrix fibre adhesion of recycled fibres for each use case. Three types of semi-finished products were developed: mats for use in thermostable processes, pellets for use in thermoplastic injection processes, and yarn for textile applications.

Finally, a demand-driven approach was applied to create innovative reprocessing chains, employing industrial recycled materials for each individual demo case. The reprocessing activities for strategy one include: (*i*) injection moulding and compression moulding of recycled bulk moulding compound (rBMC); (*ii*) injection moulding and 3D printing for thermoplastic composites; and (*iii*) impregnation with thermoset resins using lamination, light resin transfer moulding (RTM), and vacuum infusion of recycled non-woven mats for thermoset composites production. The reprocessing techniques studied within strategy two were: (*i*) plastic injection with thermoplastic materials reinforced with recycled carbon fibre (rCF); (*ii*) RTM of epoxy resin with textile laminates that include layers of the mat made with rCF; and (*iii*) yarn production from rCF.

A demo case from pilot strategy one

Automotive lightning frames made with mechanically recycled GFRP from EoL wind blades and SMC/BMC industrial scraps

One of the challenging areas of sustainability is the automotive sector, where the quest for sustainability often clashes with the technical demands of technical components.

The Lightning Frame demo case aims to develop and optimise recycled bulk moulding compound (r-BMC), formulated using a high percentage of recycled resources from thermoset scraps and EoL wind blades and enhancing the components already present in the formulations of recycled parts (additives, fibres, flame retardant if present, etc.). This new material would serve as an alternative to standard compounds formulated with virgin resources and raw materials alone. It aims to be used in all applications where regulations will demand sustainable materials, such as the automotive lighting frames, which are the main focus of the demo case.

The input materials to the demo-case activities are ground and sieved particles (both fibres and powders) obtained from the demanufacturing of EoL wind blades, thermoset composites waste or EoL of thermoset components. The reprocessing technologies, based on moulding processes (compression, transfer, and injection moulding), have been optimised in terms of equipment and process parameters, and together with the mould, to produce the components.

The activities within this demo case open a re-evaluation and suggest potential new applications of thermoset materials.

A demo case from pilot strategy two

Hybrid yarn combining technical fibres from recycled composites and technical waste

The textile market is constantly increasing. Currently, less than 10% of its production comes from recycled fibres, since most of the pre- and post-consumer textile waste is not recovered. Developing and demonstrating circular solutions for textiles would reduce the environmental pressure related to production and waste management and valorise EoL products.

The hybrid yarn demo case aims to realise a hybrid yarn made by combining technical fibres from the recycling of CFRP, GFRP and textile waste as input materials. The output product is a yarn that, due to its properties, can be used to develop fabrics with various potential technical applications (e.g. building, safety, industry). The hybrid nature of the product leads to a combination of high performances (from CF and GF) with 'textile' properties.

The process chain includes a preliminary mechanical (shredding, fraying) and thermal (pyrolysis) treatment of the input material. The resulting mass of fibres is then processed by textile (secondary) spinning to produce a yarn that can yield a fabric by weaving.

With the aim of improving the environmental sustainability of the demo-case activities, waste from hybrid yarn production will be processed to create mats/non-wovens through mechanical processes such as airlay and needle-punching. The resulting products can be employed for thermal and acoustic insulation.

Cascade funding – the two Open Calls of DeremCo

As part of its efforts to maximise impact, DeremCo has introduced a Financial Support to Third Parties (FSTP) grant scheme, under which two Open Calls were issued.

This scheme aims to reinforce DeremCo's demonstration activities by providing financial support to develop new circular business models and technological solutions in the composite sector, particularly driven by SMEs. These solutions are designed to achieve high technology readiness levels (TRLs), thereby enhancing the profitability and viability of DeremCo's business cases.

PROJECT SUMMARY

DeremCo pioneers a cross-sectoral circular economy model for reusing end-of-life composite materials. Through 14 industrial pilots, it validates innovative demanufacturing and reprocessing techniques, integrating digital traceability and stakeholder engagement. The project aims to transform composite waste into high-value products, fostering sustainable growth and investment across European value chains. DeremCo is a collaborative initiative involving 29 partners from Austria, Belgium, Finland, Italy, Portugal, Slovenia and Spain.

PROJECT PARTNERS

AFIL – Associazione Fabbrica Intelligente Lombardia, Birziplastik, Business Upper Austria - Bizup, Center za Aplikativne Polimer (CAP), Caracol, Carbon Cleanup, Centro Tessile Cotoniero e Abbigliamento, Comissao de Coordenacao e Desenvolvimento Regional do Centro (CCDR), Enel Green Power, Fibereuse Tech, Fondazione Politecnico di Milano, Faculty for Polymer Technology (FTPO), Fundacion Tecnalia Research & Innovation, Greenthesis Group, Holonix, IDEC, META Group, NTS SPA, O.P.S. Breznik, Origoni Steiner, Politecnico di Milano, R&D Consulting, Tampere University, Technol, TEHNOS, Turnaplast, Veltha, Veplas Group, Wood K plus.

PROJECT LEAD PROFILE

Prof. Marcello Colledani is a Full Professor at Politecnico di Milano, specialising in sustainable manufacturing and circular economy systems. A Fellow of the CIRP, he has conducted research at MIT and coordinates major EU projects including FiberEUse, DigiPrime, DeremCo, BATTwin, and BatMass. He leads the CIRC-eV lab and regional circular economy initiatives within AFIL.

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